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Drill string component

Field of the invention

The invention relates to a drill string component for use in a drilling process as defined in the preamble of claim 1.

The invention further relates to a method, a drilling apparatus and a reamer of the kind defined in the preambles of claims 8, 13 and 14, respectively.

Background of the invention

Drilling apparatuses may be used in a number of applications. For example, rock drilling apparatuses may be used in tunnelling, underground mining, rock reinforcement, raise boring, and for drilling of blast holes, grout holes and holes for installing rock bolts.

Common for drilling processes is that the drill cuttings have to be moved from the cutting face during the drilling process. Depending on drilling method, this may be accomplished in a number of ways. For example, one common method is to flush the drill cuttings away from the hole with a suitable medium. The drill cuttings may for example be flushed out of the hole by a flushing medium that is fed through a tube in, preferably the center of, a drill string connecting a drill tool to a drill rig, and discharged near the drill tool in order to also cool the drill tool. The flushing medium then flushes the drill cuttings through and out of the hole. This flushing medium is usually air in surface drilling apparatuses and water in underground working apparatuses. Alternatively, watermist with or without a chemical additive or foam may be used in both types of apparatuses.

In certain rock drilling processes, a drill tool is used having the form of a cutter head such as a reamer with a substantially larger diameter than the drill string. Further, a pilot bit having smaller diameter may be used to align the reamer in a correct drilling direction and to ensure that the drilling process is carried out in a desired direction throughout the drilling of the particular hole.

One problem that is encountered in this type of drilling, however, is how to cool and/or flush desired parts of a cutter head, such as pilot bit cutters and/or reamer cutters, during the drilling process and at the same time take care of its drill cuttings, which may be constituted by the more extensive drill cuttings yielded by the larger reamer and drill cuttings resulting from the pilot bit. If for example the flushing and cooling method described above is used, the drill cuttings during more or less upwardly directed drilling falls down through and out of the hole via the space between the drill string and the rock wall. If the drilling is performed in a narrow drift, this makes it difficult to remove the drill cuttings in an efficient way. There is also always a risk that pieces of rock might fall down and cause damages to the machine and/or its operating personnel.

In certain types of applications, the flow may be reversed and the drill cuttings may be evacuated through the drill string. This however, requires that the hole area surrounding the drill string can be covered and connected to a flush medium supply to force the drill cuttings to be evacuated through a channel in the drill string. This solution may, however, apart from being difficult to implement in an efficient way in a narrow drift, disturb the drilling performance of a pilot bit, if used. Further, the pilot bit will be ineffectively cooled.

Summary of the invention

It is an object of the present invention to provide a drill string component for use in a drilling process that solves the above mentioned problem.

This object is achieved by a drill string component according to the characterizing portion of claim 1.

It is a further object of the present invention to provide a drilling method that solves the above mentioned problem.

This object is achieved by a drilling method according to the characterizing portion of claim 8.

It is also an object of the present invention to provide a drilling apparatus that solves the above mentioned problem.

This object is achieved by a drilling apparatus according to the characterizing portion of claim 13.

Another object of the present invention is to provide a reamer that solves the above mentioned problem.

This object is achieved by a reamer according to the characterizing portion of claim 14.

The drill string component according to the present invention comprises a first channel for evacuating drill cuttings from a rock cutting surface and a second channel separated from the first channel for supply of a medium for cooling and/or flushing to the drilling area. This has the advantage that cooling and/or flushing medium may be supplied to the drilling area via the drill string while at the same time drill cuttings may be evacuated through the drill string thus enabling an efficient way of taking care of the drill

cuttings. This is particularly but not exclusively advantageous in narrow drifts.

The first and second channels may be constituted of essentially concentrical tubes, and the outer tube may be constituted by the outer casing. The drill cuttings may be evacuated through the inner tube. This has the advantage that the drill cuttings may be evacuated with the least possible abrasive action on the drill string.

The drill tool may be a cutter head with a large diameter such as a reamer connected to or integrated with a pilot bit of smaller diameter. This has the advantage that drilling of a hole may be performed in a single process with the pilot bit making it possible to perform the drilling in a desired direction, while simultaneously drill cuttings are removed in an efficient way.

The cooling and/or flushing medium may be used to cool and/or flush the pilot bit and/or its drill cuttings. This has the advantage that drilling may be performed at desired speed with sufficient cooling while still handling the drill cuttings efficiently.

The evacuation of the drill cuttings may be arranged to be effected by suction through the channel or tube used for evacuating the drill cuttings. This has the advantage that a suction device may be used to force drill cuttings through the drill string via suction and thus collect the drill cuttings at a preferred location.

The suction may be arranged to be effected from a remote location and be arranged to effect suction from two or more separate drilling apparatuses. The suction device may then be connected to a plurality of drilling apparatuses in the mine,

simultaneously or one at a time, thus making it possible to eliminate the need of several suction devices and thus to collect drill cuttings from several drilling locations at a central location.

The inner tube may be arranged to be a replaceable tube, for example a PVC tube. This has the advantage that the drill string components may be repaired at a considerably lower cost than would be the cost of replacing them with new ones.

Brief description of the drawings

Fig. 1 is a section through a drift extending through a rock and a rock drilling apparatus therein for drilling a series of intersecting holes.

Fig. 2 shows a front view of the rock drilling of fig. 1.

Fig. 3 shows in a longitudinal section a reamer and a drill string component according to the present invention.

Fig. 4a and 4b show in a longitudinal section and a front view, respectively, a drill string component according to the present invention.

Fig. 5 shows in a side view and a front view a reamer according to the present invention.

Detailed description of exemplary embodiments

In figs. 1 and 2 is shown a rock drilling apparatus 1 suitable for use with the present invention. The particular apparatus 1 shown is especially designed for use in a method of extracting ore from an ore-bearing rock, where the ore is present in a layer extending through said rock and having an at least approximately defined thickness in a plane extending across said layer. This method is described in more detail in the

Swedish patent application 0303100-2 and is carried out by performing the following steps:

a) providing a drill having a diameter substantially corresponding to said approximately defined thickness;

b) drilling with said drill through at least a portion of said layer a first hole along a first axis located in a plane substantially perpendicular to said plane;

c) drilling with said drill at least a second hole adjacent said first hole along a second axis spaced from said first axis less than said diameter; etc..

In Fig. 1 the rock drilling apparatus 1 is shown having at its left end a compartment for storing drill string components 2' to be assembled into a drill string. A derrick 8 includes assembling means for assembling the drill string components into a drill string getting longer and longer as the drilling process goes on. The assembling means may be constituted by a holding wrench.

In fig. 2 is shown a front view of the rock drilling apparatus in an ongoing drilling process. As is shown, the apparatus 1 is used to excavate an inclined cylindrical portion of a rock formation.

The drilling is performed by a reamer 3 with a relatively larger diameter. The reamer 3 is mounted together with a pilot bit 4 of a smaller diameter. The pilot bit is used to ascertain that the drilling is performed in a desired direction throughout the drilling of the particular hole. The reamer 3 is carried by a drill string 2, at present constituted by drill string components 2a, 2b, 2c, where additional drill string components 2d, 2e, etc. (not shown) may be added to the drill string by the assembling device as

the drilling process progresses until a hole of desired length has been acquired. Each drill string component 2' may for example be of 1000 mm length.

The yielded drill cuttings must continuously be removed and taken care of to prevent the apparatus from being buried in drill cuttings and to prevent damages of the apparatus and/or operator. As described above, one common way of taking care of the drill cuttings is, as the reamer is of a larger diameter than the drill string, to let the drill cuttings fall or be flushed out of the hole in the space between the drill string and the rock wall. For machines working in narrow drifts, and particularly for machines as the one described in figs. 1 and 2, which during drilling is secured to both the drift walls and its top and bottom and taking up most of the space in the drift, there is little space left to perform this collecting operation in an efficient way, and if the hole to be drilled is long, the resulting amount of drill cuttings may be extensive.

In fig. 3 is shown a drill string component 30, at one end connected to a reamer 31, and at its other end being intended to be connected to another drill string component or, if the drilling process is in its beginning, the rock drill device. The actual rock breaking action is performed by continuously applying pressure onto the drill string so that the pilot bit cutters 32, and the reamer cutters 33, 34 are continuously pressed against the rock, while simultaneously the drill string is rotated. In this example, the pilot bit cutters are constituted by three conically shaped roller bits with tungsten carbide inserts and each with an axis inclined at an angle relative to the normal to the axis of the drill string in such a manner that the pilot bit cutters are normal to the drill string when facing the rock. The diameter of the roller

bits may for example be 9-14 inches. The reamer cutters 33, 34 are arranged in two ways as can be seen in figs. 3 and 5. The cutters 33, 34 cause annular kerfs, and when the kerfs are deep enough the rock between the kerfs falls off. The cutters 36 are provided to make sure that the reamer may be pulled out of the hole backwards towards the machine without getting stuck when the drilling of the hole is finished and the machine is to be moved to another hole. The reamer diameter may for example be 500-2000 mm. The distance between the pilot bit cutters 32 and the reamer cutters may for example be 500-1000 mm.

The drill string components are provided with two channels. This can be seen in fig. 4 where there is a first channel 41 in the center of and coaxial with the drill string component 40. The first channel might for example be defined by a tube 46, such as a PVC tube, a tube made of other plastic, a metal tube or a tube made of a ceramic material. Between, and limited by, the tube 46 and the outer casing 42 of the drill string component 40 there is a second channel 43. In this embodiment, the second channel 43 is constituted by two tubes 43a and 43b. Also the tubes 43a, 43b may for example be constituted by PVC tubes, tubes made of other plastic, metal tubes or tubes made of a ceramic material. In this exemplary embodiment, the center channel is used to evacuate drill cuttings, as will be explained below, and the outer channel 43 is used to supply the pilot bit with a cooling and/or flushing medium. The pilot bit needs cooling due to its compact construction. The center channel may be constituted by a replaceable tube. This is because the channel is used to evacuate the drill cuttings and is therefore subject to substantive wear during the drilling process. Replacement of a tube, such as a PVC tube or metal tube, is considerably

cheaper than would be to replace the whole drill string component. The flushing and/or cooling medium may for example be constituted by air, water, watermist with or without a chemical additive or foam depending of what is suitable for the particular application.

When two drill string components are connected together, drill cuttings are transported from one drill string component to the other by the larger centrally located hole 44 in fig. 4b, while the flushing and/or cooling medium is transported via annularly located smaller holes 45.

In fig. 4, the second channel is shown as constituted by two tubes 43a, 43b. The second channel could however be constituted by one or three or more tubes as well. Also, the second channel could be constituted by the space between the tube 46 and the outer casing. This however, might require a rather large amount of cooling and/or flushing medium to fill up the space between the tube 46 and the outer casing in each drill string component.

When the drilling process is in progress, the rock is broken into pieces as described above. The cooling/flushing medium is fed to the pilot bit along the solid arrows 35 in fig. 3 and discharged near the pilot bit cutter 32. In this way the pilot bit cutters are cooled while simultaneously the drill cuttings of the pilot bit are flushed away from the pilot hole. These drill cuttings are then, along with the drill cuttings produced by the reamer, led to the center channel 41, e.g. either by the attraction of gravity when drilling upwards or as will be described below, in the drill string via inlets 50 between the reamer cutters (shown in figs. 3 and 5) and a channel 52 in the reamer along the dashed arrowed line 51. These inlets may preferably be covered by wire netting or

grating to prevent large pieces from getting stuck in the inlets. Thus, as can be seen in fig. 3, the flows are changed over in the reamer so that cooling and/or flushing medium is fed to the pilot bit in or near the center of the axis of the drill string, this changeover may for example be carried out by leading the cooling and/or flushing medium via a tube 37 as shown in fig. 3.

The channel in the drill string used for evacuating drill cuttings might advantageously be connected to a suction device. The other channel is still used for providing cooling and/or flushing medium to the drilling area. The suction device then sucks all drill cuttings from both the pilot bit and the reamer via the channel in the drill string.

This is illustrated in figs. 1 and 2, showing a rock drill apparatus particularly suitable for use in drilling holes inclined +/- 20° relative the plane A in fig. 2. When drilling substantially horizontally, or downwards, the drill cuttings will not evacuate through the drill string by themselves. The drill string is connected to a suction device 5 via a hose 6 (shown in fig. 1). This method thus has the advantage that the drill cuttings are taken care of in a very efficient way with little disturbance in the drilling area. In an alternative embodiment, the suction device 5 might be constituted by a central suction device, located in a dedicated location in the mine. The central suction device may then be connected to a plurality of drilling apparatuses in the mine, simultaneously or one at a time.

The method of evacuating the drill cuttings by suction may of course also be used when drilling substantially vertically upwards such as in box hole/blind hole drilling or substantially downwards or in any direction for that matter.

Further, the drill string component may comprise a third channel dedicated for supply of cooling and/or flushing medium to the reamer bits. This might be advantageous if the reamer cutters need cooling and the cooling medium supplied to the pilot pit is not sufficient to also cool the reamer cutters. The third channel could for example be constituted by one of the tubes 43a, 43b in fig. 4, or alternatively of one or more extra tubes. As an alternative to the third channel the medium supplied in the second channel may be split in the reamer to provide cooling and/or flushing to both the pilot bit and the reamer cutters.

Though the present invention has been described in connection with a particular rock drilling apparatus it is to be understood that the present invention is suitable for use in connection with any rock drilling apparatus where the drill string is used for simultaneous feed of flushing and/or cooling medium and evacuation of drill cuttings, in particular rock drill apparatuses used for box hole/blind hole drilling in for example a tunnel.

Further, in the above description, the drill cuttings have been evacuated via a channel centrally located in the drill string components while flushing and/or cooling medium has been supplied via an outer channel. It is to be understood however, that also other configurations may be used. For example, the flushing and/or cooling medium may be supplied via a centrally located channel while the drill cuttings are evacuated via an outer channel. Other configurations are also possible.

It is to be understood that also other types of bits and cutters may be used with the invention since different kinds of rock and different drilling processes may require different

kinds of cutters. For example, a cutter head without a pilot bit may be used, in which case the flushing and/or cooling medium is used to cool desired portions of the cutter head.

Claims

1. Drill string component for use in a rock drilling process, wherein the drilling is performed by a drill tool connected to a drill string including plural drill string components, the drill string component comprising an outer casing and a first channel for evacuating drill cuttings from a rock cutting surface, **characterised in**
- a second channel separated from the first channel for supply of a medium for cooling and/or flushing to the drilling area.

2. Drill string component according to claim 1, **characterised in** that the first and second channels are constituted by essentially concentrical tubes.

3. Drill string component according to claim 2, **characterised in** that the outer tube of the concentrical tubes is constituted by the outer casing.

4. Drill string component according to claim 2 or 3, **characterised in** that the drill cuttings are arranged to be evacuated through the inner tube.

5. Drill string component according to claim 4, **characterised in** that the inner tube is a replaceable tube, made by a material from the group: PVC tube, tube made of other plastic, metal tube or tube made of a ceramic material.

6. Drill string component according to any of the claims 1-5, **characterised in** that the drill tool is a reamer of a larger diameter connected to or integrated with a pilot bit of smaller diameter.

7. Drill string component according to claim 6, **characterised in** means for conducting the cooling and/or flushing medium to

the cutting face of the pilot bit so as to cool and/or flush the pilot bit and/or its drill cuttings.

8. Drilling method for use in a rock drilling process, the drilling being performed by a drill tool connected to a drill string component, the drill string component comprising an outer casing and a first channel, the method comprising the steps of:

- evacuating drill cuttings through at least one drill string component via a first channel, and
- simultaneously supplying a medium for cooling and/or flushing to the drilling area via a second channel in the drill string component.

9. Method according to claim 8, wherein a the cooling and/or flushing medium is used to cool and/or flush a pilot bit and/or a reamer cutter.

10. Method according to claim 8 or 9, further comprising the step of effecting the evacuation of the drill cuttings by suction through the channel used for evacuating the drill cuttings.

11. Method according to claim 10, further comprising the step of effecting suction from a remote location arranged to effect suction from two or more separate drilling processes.

12. Method according to any of the claims 8-11, **characterised in** that it further comprises steps for extracting ore from an ore-bearing rock where the ore is present in a layer extending through said rock and having an at least approximately defined thickness in a plane extending across said layer, said steps comprising:

a) providing a drill having a diameter substantially corresponding to said approximately defined thickness;

b) drilling with said drill through at least a portion of said layer a first hole along a first axis located in a plane substantially perpendicular to said plane;

c) drilling with said drill at least a second hole adjacent said first hole along a second axis spaced from said first axis less than said diameter; etc.

13. Rock drilling apparatus for use in a rock drilling process, wherein a drill tool is arranged to be connected to a drill string including plural drill string components, the drill string comprising a first channel for evacuating drill cuttings from a rock cutting surface, the apparatus including means for applying a pressing force on and rotation to the drill string, **characterised in** that it further includes:

- means for connecting a suction device to the first channel in the drill string, and
- means for connecting a cooling and/or flushing medium supply to a second channel in the drill string.

14. Reamer for use in a rock drilling process, wherein the reamer is arranged to be connected to a drill string including plural drill string components, the reamer comprising a first channel for evacuating drill cuttings from a rock cutting surface, **characterised in**

- a second channel separated from the first channel for supply of a medium for cooling and/or flushing to the drilling area.

Abstract

The present invention relates to a drill string component for use in a rock drilling process, wherein the drilling is performed by a drill tool connected to a drill string including plural drill string components, the drill string component comprising an outer casing and a first channel for evacuating drill cuttings from a rock cutting surface. A second channel is separated from the first channel for supply of a medium for cooling and/or flushing to the drilling area.

The invention also relates to a method, a drilling apparatus and a reamer.

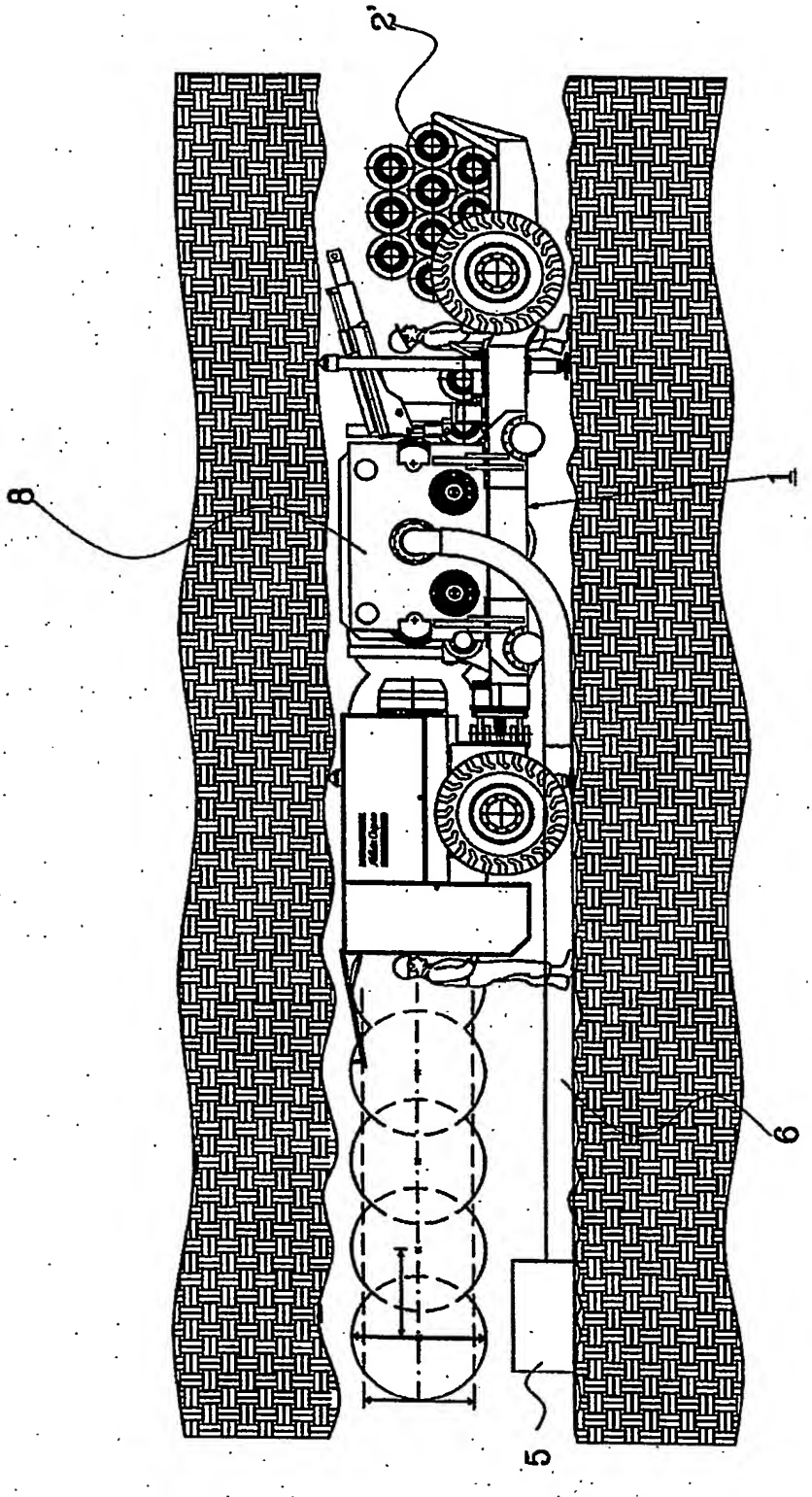

Fig. 1

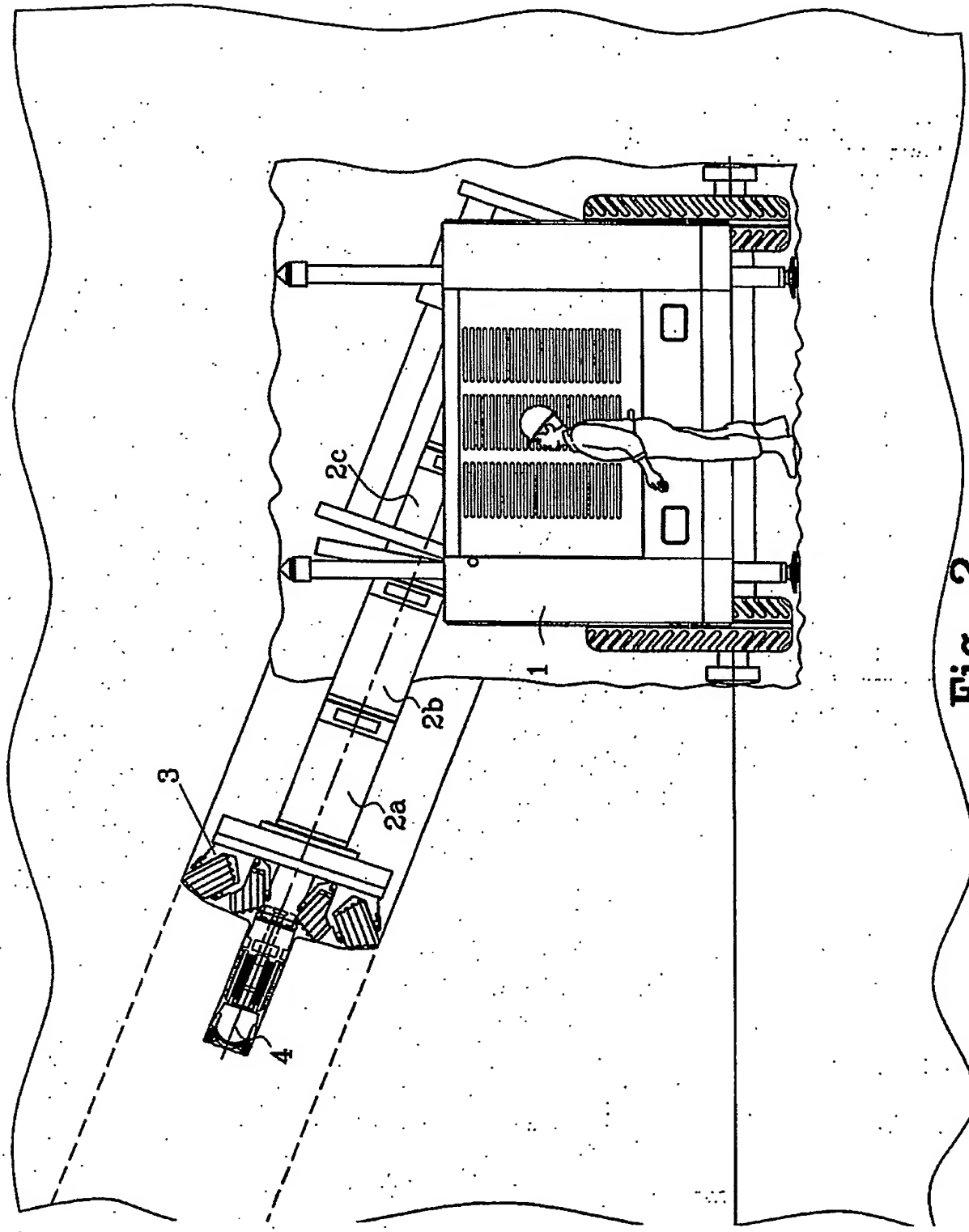

Fig. 2

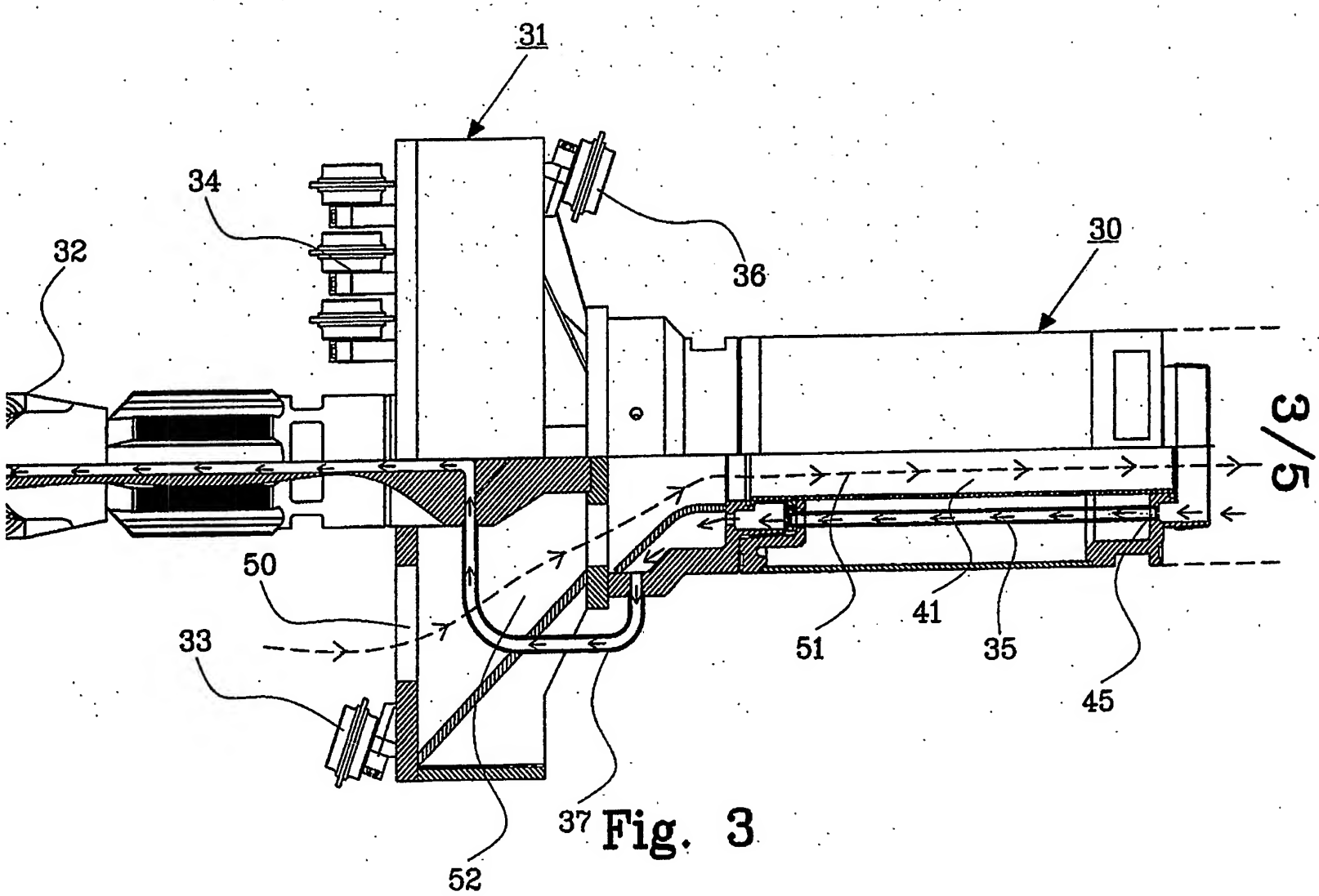

Fig. 3

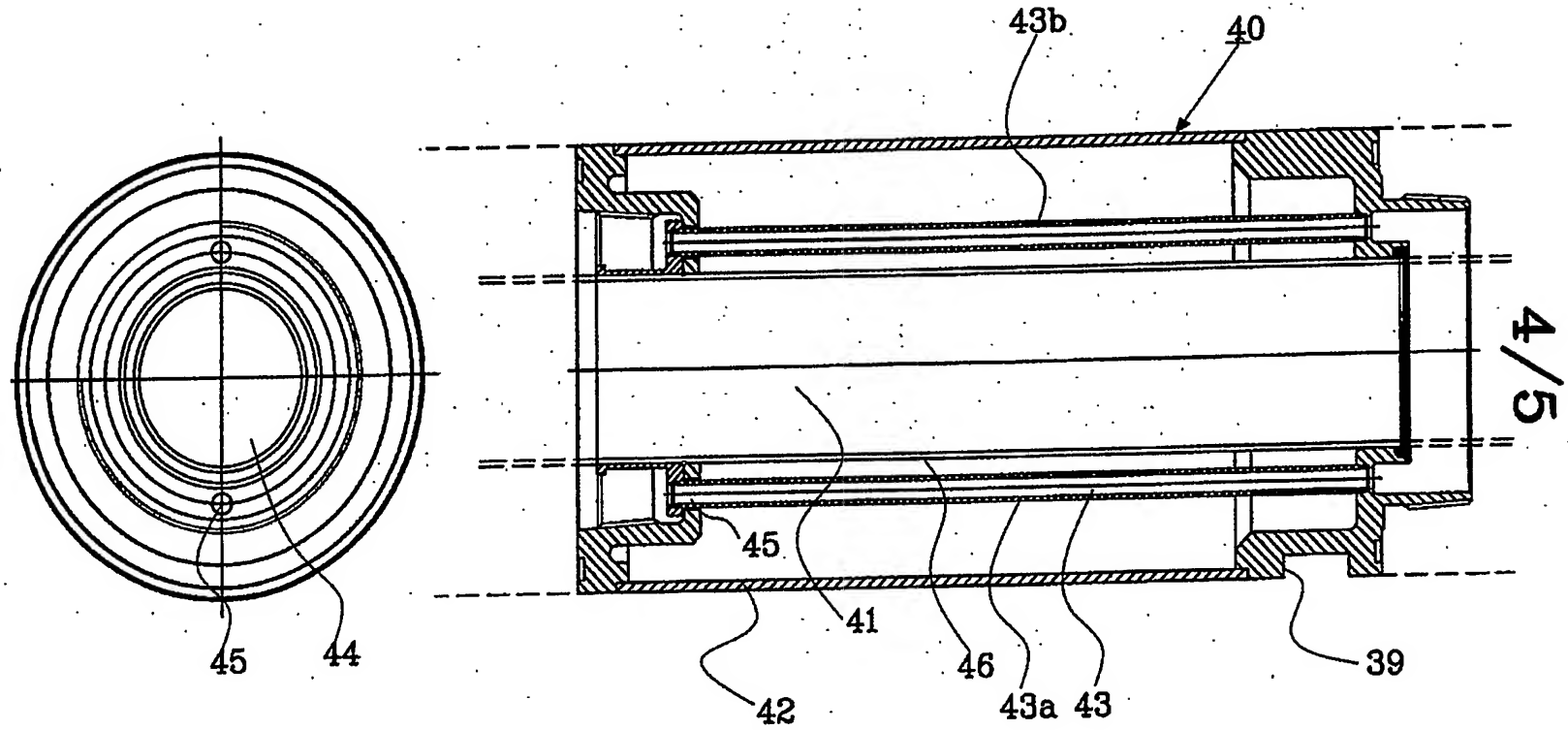

Fig. 4b

Fig. 4a

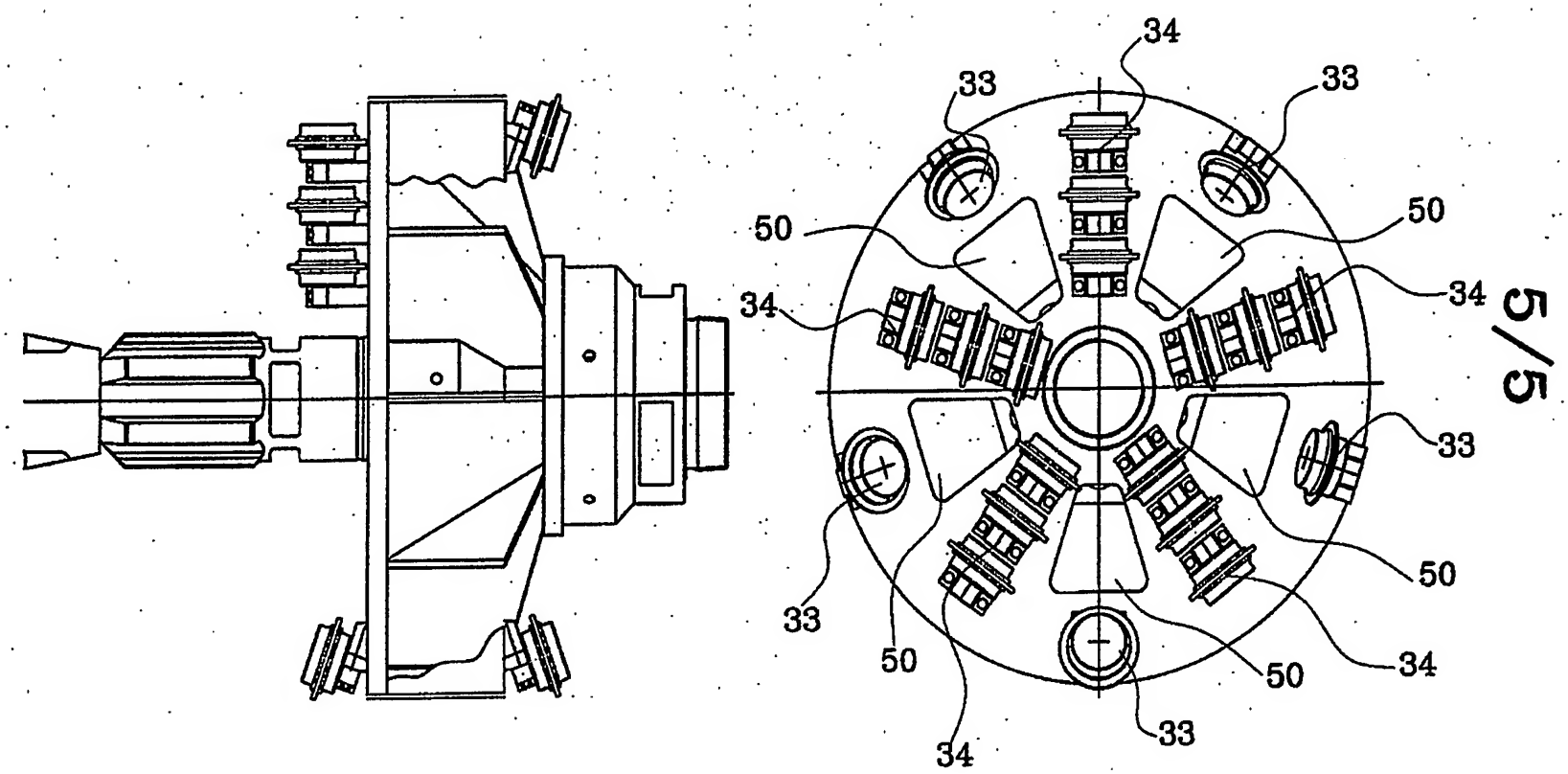

Fig. 5

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